

Brayton Power Conversion Unit Tested-- Provides a Path to Future High-Power Electric Propulsion Missions

Closed-Brayton-cycle conversion technology has been identified as an excellent candidate for nuclear electric propulsion (NEP) power conversion systems. Advantages include high efficiency, long life, and high power density for power levels from about 10 kWe to 1 MWe, and beyond. An additional benefit for Brayton is the potential for the alternator to deliver very high voltage as required by the electric thrusters, minimizing the mass and power losses associated with the power management and distribution (PMAD).

To accelerate Brayton technology development for NEP, the NASA Glenn Research Center is developing a low-power NEP power systems testbed that utilizes an existing 2-kWe Brayton power conversion unit (PCU) from previous solar dynamic technology efforts. The PCU includes a turboalternator, a recuperator, and a gas cooler connected by gas ducts. The rotating assembly is supported by gas foil bearings and consists of a turbine, a compressor, a thrust rotor, and an alternator on a single shaft. The alternator produces alternating-current power that is rectified to 120-V direct-current power by the PMAD unit. The NEP power systems testbed will be utilized to conduct future investigations of operational control methods, high-voltage PMAD, electric thruster interactions, and advanced heat rejection techniques.



Brayton PCU installed at Vacuum Facility 6.

The PCU was tested in Glenn's Vacuum Facility 6. The Brayton PCU was modified from its original solar dynamic configuration by the removal of the heat receiver and retrofitting of the electrical resistance gas heater to simulate the thermal input of a steady-state nuclear source. Then, the Brayton PCU was installed in the 3-m test port of Vacuum Facility 6, as shown in the photograph. A series of tests were performed between June and August of 2002 that resulted in a total PCU operational time of about 24 hr. An initial test sequence on June 17 determined that the reconfigured unit was fully operational. Ensuing tests provided the operational data needed to characterize PCU performance over its full operating range.

The primary test variables used in operating the Brayton PCU were heater input power and rotor speed. Testing demonstrated a maximum steady-state alternating-current power output of 1835 W at a gas heater power of 9000 W and a rotor speed of 52 000 rpm. The corresponding measured turbine inlet gas temperature was 1076 K, and the compressor inlet gas temperature was 282 K. When insulation losses from the gas heater were neglected, the Brayton cycle efficiency for the maximum power point was calculated to be 24 percent. The net direct-current power output was 1750 W, indicating a PMAD efficiency of about 95 percent.

Find out more about the research of Glenn's Thermo-Mechanical Systems Branch
<http://www.grc.nasa.gov/WWW/tmsb/>.

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